Chapter 6

A Watershed View

- Introduction to Volunteer Water Quality Monitoring Training Notebook -

"***Everything is connected to everything else.***" **–** Aldo Leopold

Knowing Your Watershed

A stream is a reflection of its watershed. Because everything that occurs within a watershed affects water resources, understanding watersheds is essential to the interpretation of stream health and water quality. If we want to preserve and protect our water resources, it is important to know how human actions are directly and indirectly altering watersheds. With this knowledge you can become an educated advocate for Missouri's streams.

Water is a vital resource. We use it for drinking, bathing, recreation and for growing our food. Since everyone is dependent on water, it is important that we protect our water resources. Before we can protect waterways, we need to understand how watersheds are defined and how they are impacted by natural phenomena and human activities. This exercise is designed to educate about the importance of taking a watershed view. By mapping your watershed, you will become familiar with the impacts in your watershed. The Watershed Mapping Activity does these things:

1. Helps to identify potential sources of pollution
2. Helps to identify monitoring sites
3. Provides information to educate the local community about potential pollution sources and the stressors affecting your stream and its watershed
4. Provides a blueprint for possible community restoration efforts such as cleanups and tree plantings
5. Provides a sense of the value of the stream and its watershed

Equipped with this knowledge, you will have the ability to make informed decisions about current and proposed activities in your watershed.

Defining Watersheds

A watershed, or drainage basin, is the area of land that drains into a particular body of water. Watersheds can range in size from less than an acre to millions of square miles. At its mouth, the Mississippi River has a drainage area of over 1.2 million square miles. Large drainage basins are made up of many smaller watersheds or sub-watersheds. The Missouri River is a sub-watershed of the Mississippi River. The Gasconade River, a tributary of the Missouri River, is a sub-watershed of the Missouri. This network is almost infinite. We all live, work, and play in a watershed.

The boundaries of a watershed are determined by topography, which is the shape or the physical features of the land's surface. If the highest points of land surrounding a river were connected (like "connect the dots"), this line would form the watershed boundary.

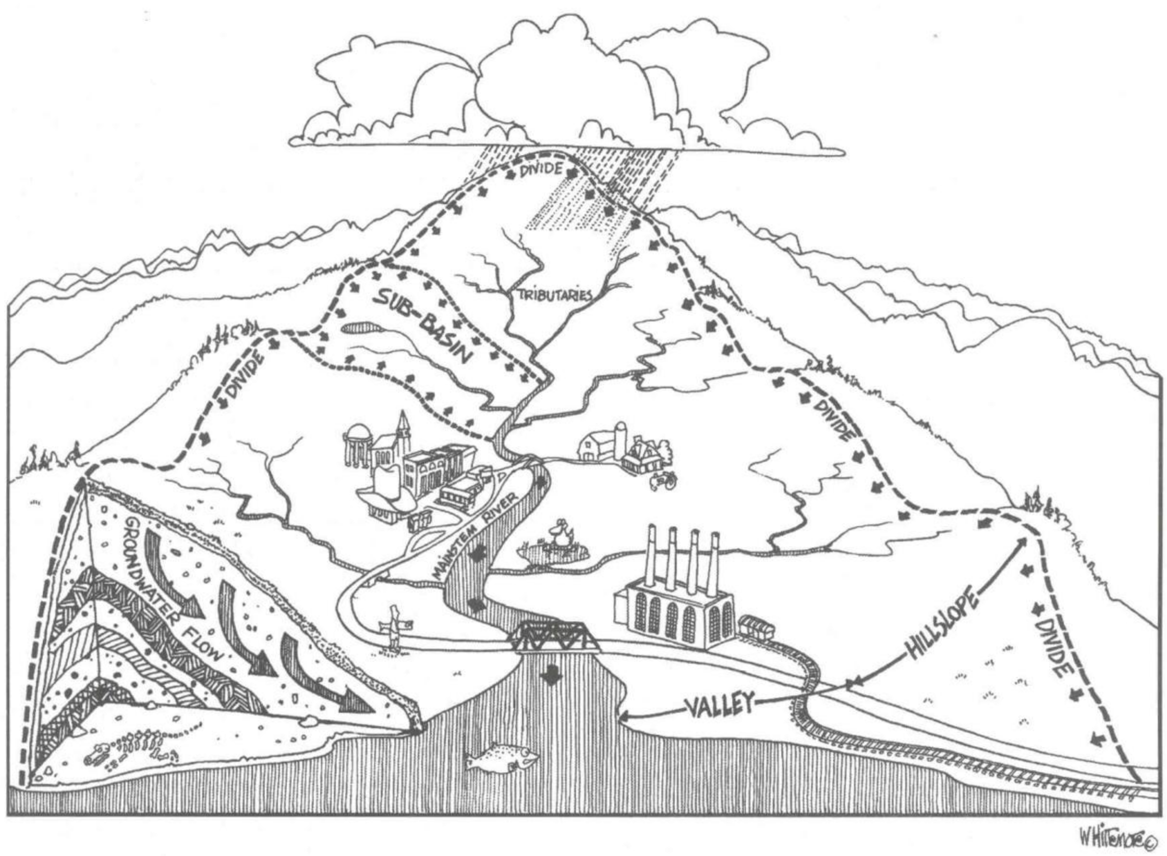


Figure 1. Watersheds are interconnected land-water systems
(from *The Streamkeeper's Field Guide*)

This boundary is the divide between watersheds (Figure 1.). Precipitation that falls on one side of a divide will drain into that watershed's streams. In a watershed, the system of stream channels that transports water, sediment and other materials is called the drainage network. Stream channels link together like branches of a tree, with each stream draining into a successively larger waterway. Each stream follows a path from the headwaters (highest elevation in the watershed) where the stream originates to the mouth (lowest elevation) where the stream empties into another body of water.

Water in headwater streams comes from a variety of sources, such as snow melt, surface runoff, groundwater seepage or springs. Tributaries join the small headwater streams and add to the flow. As more tributaries enter the stream, it gets larger and changes physically, chemically and biologically. The shape of the channel, the stream's gradient or slope, and the substrate all change as the stream flows from its headwaters to its mouth.

Watershed Dynamics

A watershed is the land area that water flows across, or under, on its way to a stream or lake. All parts of a watershed are interconnected. Something that occurs in the headwaters can affect distant areas downstream. As water runs downhill, it picks up whatever is on the ground. As water flows across and through urban areas, fields or pastures, it can pick up silt, pollutants or even heat. These contaminants eventually flow into a stream or lake, affecting the quality of the water you use to drink, swim or fish. Anytime someone flushes the toilet, does laundry, fertilizes the lawn or dumps used oil on the ground, the water quality within the watershed is impacted.

Topography, soils, geology and chemistry all affect watershed health and water quality. The most pervasive threat to water quality in the United States is increased siltation due to runoff and erosion. At present, the average soil erosion rate in Missouri for cropland is 4.5 tons (9,000 pounds) per acre. In 1995 it was estimated that 95 million tons of soil eroded from Missouri's cropland. That is enough to bury all four lanes of I-70 between St. Louis and Kansas City under thirty feet of soil.

The degrees of slope, land use and soil type influences the amount of runoff and erosion that occurs in a watershed. Steep slopes have a high degree of runoff and are more susceptible to erosion. Areas that have been disturbed and do not have vegetation on them will have increased runoff and erosion. Soil type also influences that amount of runoff and erosion in a watershed. Small particles such as silt are more easily eroded than coarse materials, such as sand or gravel.

Human uses of land and water also impact water quality. One way that humans influence watersheds is by constructing impervious surfaces, which are non-porous so that water cannot penetrate them. Examples of impervious surfaces are streets, parking lots and rooftops. Impervious surfaces increase the amount of runoff and therefore the potential for erosion. In undisturbed areas, features such as wetlands, uncompacted soils and vegetation are able to absorb water runoff and reduce erosion. If these natural sponges are replaced by impervious surfaces, less water is absorbed and a larger volume of water flows more quickly to waterways through ditches or storm drainage pipes. This increased runoff adds to stream volume and velocity, which can cause stream bank erosion, sedimentation and flooding (Figure 2.).

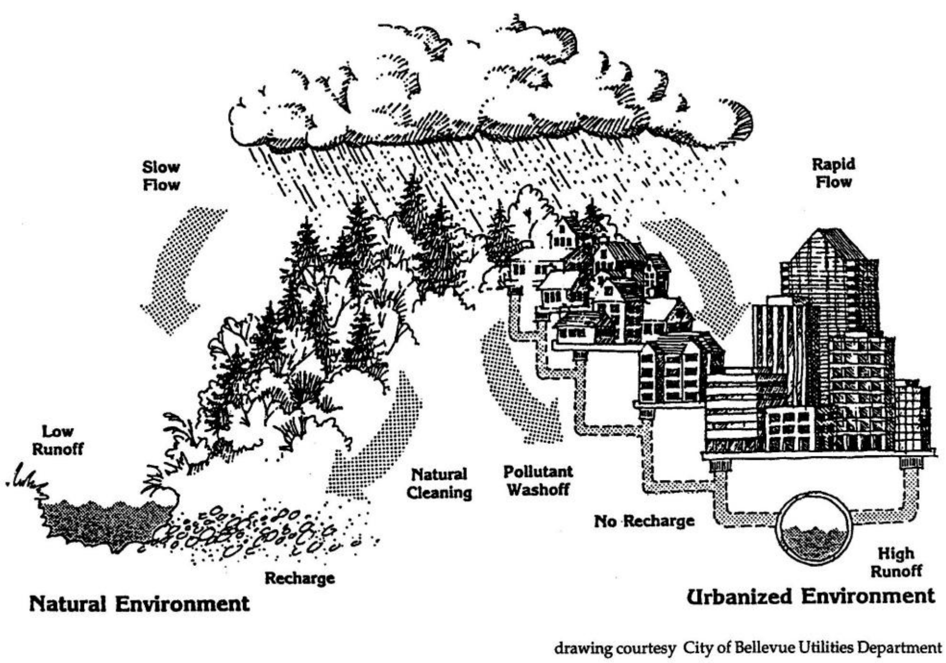


Figure 2. Effects of urbanization and impervious surfaces on a watershed
(from *The Streamkeeper's Field Guide*)

Industrial and agricultural activities can also alter watersheds and impact a stream through point and nonpoint sources of pollution. Point source pollution can be traced to a specific source. Examples include a pipe discharging pollutants from an industrial plant or sewage treatment facility. All point discharges should have a "State Operating Permit" issued from the Missouri Department of Natural Resources' Water Protection Program. Since the State of Missouri has primacy (authority) over clean water law in this state, EPA defers to Missouri's State Operating permits. Nonpoint source pollution (NPS) arises not from one specific source, but from a number of diffuse sources. Because the source of nonpoint pollution is harder to identify, it is difficult to control.

Nonpoint source pollution, generated by human activities throughout a watershed, usually reaches waterbodies via surface runoff. Agriculture and urban runoff are the greatest sources of nonpoint pollutants. Soil erosion, animal waste, fertilizer and pesticides from cropland can seriously degrade streams. Heat and pollutants from street and parking lot runoff, fertilizer and pesticides from lawns, parks and golf courses, sediment from construction sites, cleaning products and pet waste can all reach streams and rivers through nonpoint runoff**,** contributing to the degradation of our water supply.

Mapping Watersheds and Understanding Maps

"*Expanses unknown to deed or map are known to every dawn*." – Aldo Leopold

Your goal is to construct a map that will show watershed boundaries, topographic and land use. Land use information can be gathered from a variety of sources, such as government agencies, businesses and environmental or civic groups. After collecting land use information, you will be able to assess the health of your watershed and monitor changes. Instructions on how to create a land use overlay for your watershed map are given later in this chapter.

Since the goal is to know your watershed thoroughly, it is important to select an area that is of manageable size. If you are working on a stream that has a large watershed, you may want to map a limited portion of the stream and watershed. When selecting your area, you should also consider personal connections you may have to a particular watershed.

NOTE: Watershed boundary and land use maps you choose to create for your adopted stream are for your personal use. You **do not** have to submit them to the program with your sampling data.

The United States Geological Survey (USGS) publishes the topographic maps you will use for this activity. Some of the sources for USGS “topo” maps are listed in Chapter 10, *Appendix*. Sometimes camping or outfitter stores will carry these maps, so check stores in your area. We suggest that you have your map laminated to protect it during field use. Also, if you use water-soluble markers, a laminated map can be wiped off and notes changed as needed.

You will need at least one USGS topographic map to complete this project. To determine which map or maps you need, see the instructor to find your watershed on the *Index Map of Published Topographic Sheets* in Missouri. The index map shows the boundaries of the USGS quadrangle maps. They are called quadrangles or “quads” because each map has four equal sides in terms of degrees of latitude and longitude. We use the most detailed maps from USGS – the “7.5-minute” series. These quads show 7.5 minutes of longitude (~7 miles) by 7.5 minutes of latitude (~8 miles).

To use these maps effectively, it is important to understand their language. Maps cannot be as large as the area they represent so they must be drawn to scale. Scale is written as a ratio. For example, scale on 7.5-minute maps is “1:24,000.” This means that one unit of measure on the map is equal in 24,000 of the same units on the Earth’s surface. Another way to understand the scale is to imagine that a map with a scale of 1:24,000 is 1/24,000 the size of the area it represents on the Earth. On a 1:24,000 scale map, 1 inch = 24,000 inches, which is 2,000 feet. [Note that a mile = 5,280 feet.]

Since all maps use symbols to represent features, you must be able to interpret the symbols in order to read the map. Different types of maps use different symbols so each one has a specific key or guide to the symbols and their meanings.

Topographic maps are the best type of reference map to use because the map illustrates the shape and elevation of features using contour lines or shaded relief. It takes practice, but once you become familiar with using topographic maps, you will be able to visualize your watershed in three dimensions. USGS topo maps show relief using contour lines. **"Relief"** is the variation in elevation of the Earth's surface. **"Elevation"** is the height in feet (or meters) above sea level of a particular point or line. An individual **"contour line,"** seen in brown on topo maps, connects points of equal elevation. The thicker brown lines will always have an elevation number on them somewhere along the line. The lighter brown lines may or may not have numbers. If they don't have a number displayed, you will need to determine the elevation using the **"contour interval"** -- the vertical difference in elevation between two adjacent contour lines. This can be illustrated using a fist and hand (reference Figure 3.).

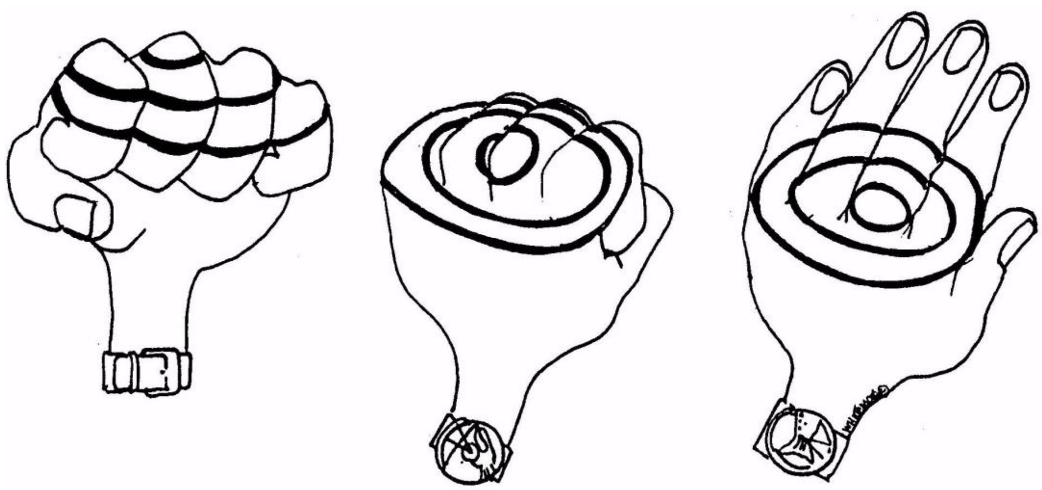


Figure 3. Contour lines can be illustrated by using a fist and hand.
(from *The Streamkeeper's Field Guide*)

This interval varies from map to map depending on local relief. Flat areas in Florida may only have 2 feet between lines, where an 80-foot contour interval will be found on maps of the Rocky Mountains west of Denver, Colorado. It is important to know the contour interval for the map you use, so look for it on the bottom, center of each map.

When using contour lines to determine watershed boundaries, it is important to remember four rules: 1.) a contour line *never* goes up or down hill, 2.) contour lines *never* cross each other, and 3.) the closer together the contour lines, the steeper the slope, and 4.) the rule of the "V"s. When contour lines cross a river or stream, they make a "V" shape. Knowing the tip of the "V" always points upstream will help you to determine the direction of flow. The rule of the "V"s also applies to ridge tops. On a topographic map, hills or ridge tops are shown as a closed circle (not necessarily a round one). As contour lines extend out from the hill or ridge top (going downhill), they often form rows of parallel “V”s (Figure 4.). These “V”s, when seen rippling outwards from a ridge top, point downhill toward lower elevations.

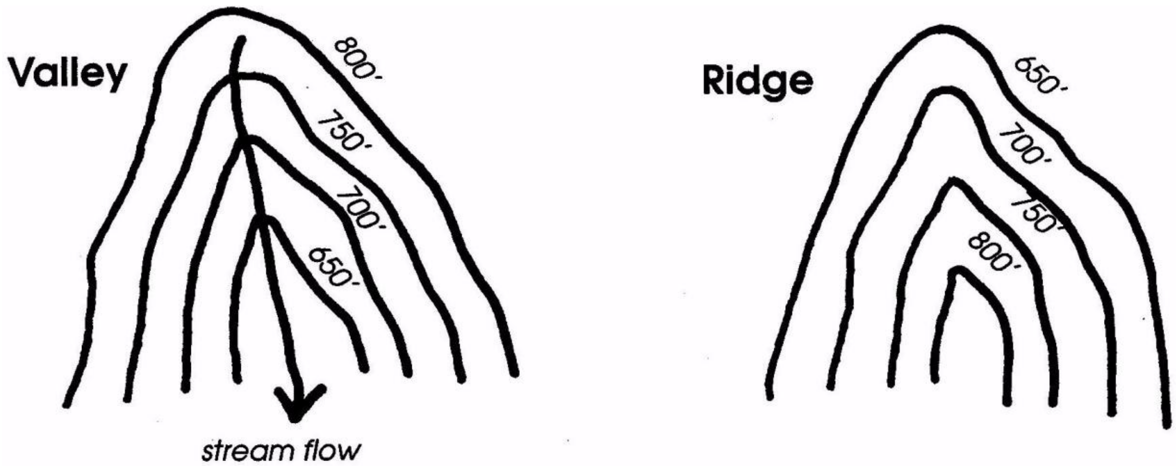
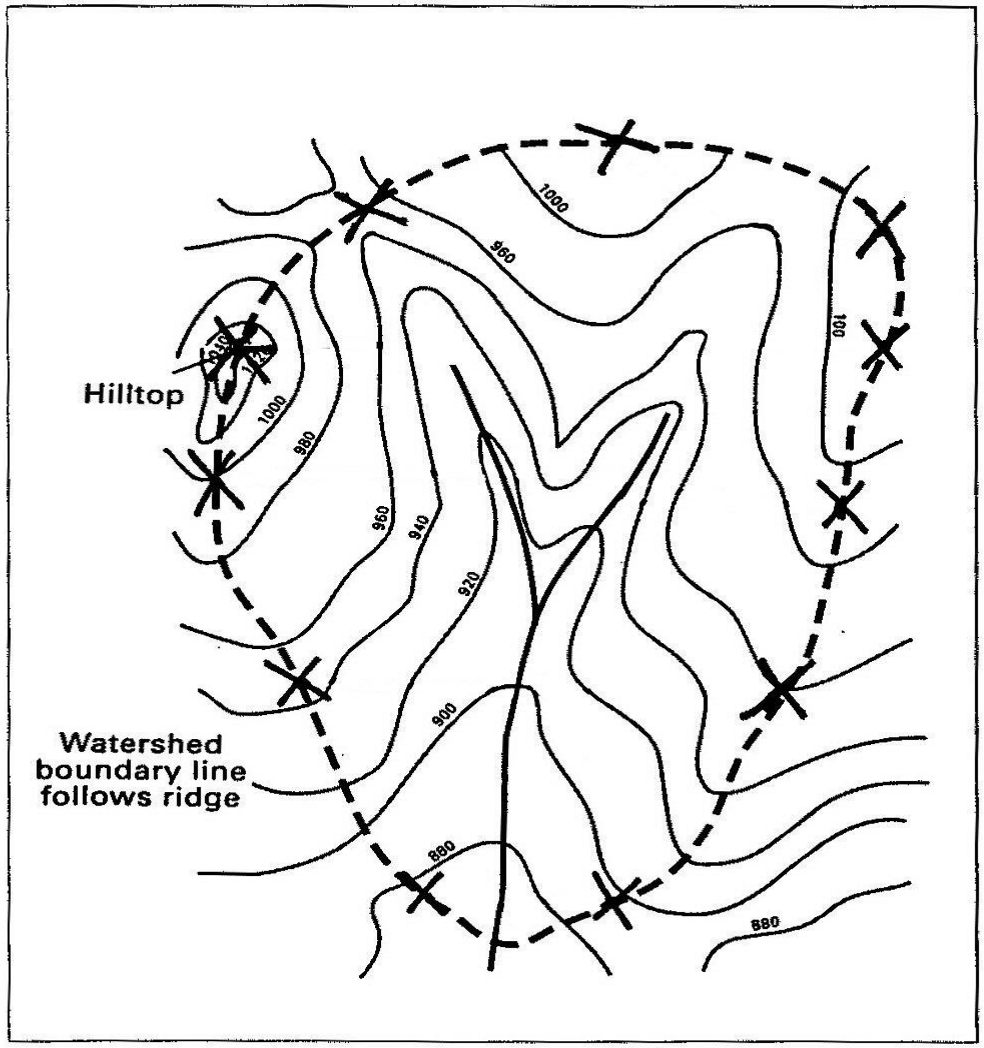


Figure 4. Topographic map with a 50-foot contour interval.
(from *The Streamkeeper's Field Guide*)

Creating a Watershed Map

1. Once you know how to interpret maps, you will be ready to create a map of your stream's watershed. On your USGS quad map(s), mark the furthest downstream point you will evaluate. All waterways upstream from this point are in your watershed. If you are mapping a segment of a large stream and watershed, mark the upstream and downstream points of your segment on the topo map(s). Use a blue marker to trace your stream and all its tributaries. Use arrows to mark the direction of flow if it helps you read the map.

2. With a pencil, mark the highest points of elevation surrounding your stream and its tributaries with “X”s (Figure 5.). One way to find high points is to look for hill tops or ridge tops, represented by closed circles. If the high spot is a peak, the circle will look more round. If the high area is a ridge top, the closed circle may be elongated in shape. Connect the highest points of elevation to outline the boundary of your watershed. Note that roads are often built along ridge tops, and watershed boundaries never cross a stream (at least not in the headwaters). Keep in mind that every drop of water that falls within these boundaries will eventually drain into the stream you have adopted.



Idealized Watershed Boundary. Adapted from *Method for the Comparative Evaluation of Nontidal Wetlands in New Hampshire.*

Figure 5. Idealized Watershed Boundary. Adapted from *Method for the Comparative Evaluation of Nontidal Wetlands in New Hampshire*.

3. Note every confluence (the point where one stream joins another) and any known point source pollution discharge. You may want to monitor water quality above and below these particular sites (see Chapter 2, *Site Selection and Identification* in this notebook).

4. Conduct a "visual assessment" of your watershed by driving, walking and/or floating through the watershed and along the stream. The purpose of driving or walking through the watershed is to get an overall picture of the land that drains into your adopted stream.

This will provide you with first-hand knowledge of the conditions of your watershed and stream. Look for the following as you drive or walk through your watershed.

a) Look at the lay of the land. Become familiar with the hills, valleys and low areas along the stream that frequently flood (this is the floodplain).

b) Look for evidence of how the community has dealt with the stream and its potential for flooding. Are portions of the stream flowing through concrete channels? Has riprap been placed along the banks? Is it dammed, diverted, leveed or straightened? Is there evidence of erosion at the bridges and road crossings?

c) Look for activities and land-use practices that might affect the stream. In particular, look for construction sites, parking lots, golf courses, manicured lawns, gullies in row crop fields, cattle with unrestricted access to the stream, mining, industrial and sewage treatment plant discharges, open dumps and landfills. Look for outfalls you identified in your background investigation. Also look for forested land, healthy riparian corridors and undisturbed wetlands.

Aerial Photograph Maps

Aerial photograph maps are based on photographs taken from airplanes. They show details that cannot be represented on other maps. These maps can be an aid in determining land-use in your watershed. Chapter 10 of this notebook, *Appendix*, provides possible sources of aerial maps for your area. Be sure to check the date on aerial maps, because land use changes rapidly so the photograph may or may not represent the current conditions.

Creating a Land-Use Overlay

Combine the information you collected during your Background Investigation and Visual Assessment with your USGS topographic map(s) to make your land-use overlay map. First, tape your topographic map to a flat surface. Tape an overhead transparency sheet over your base map. The sheet must be large enough to cover your entire watershed. Use all the information you have gathered about your watershed to mark land use. You may want to use different colors or symbols to represent different uses. Here are some suggested uses of land and potential impacts that you could include on your map:

Pasture
Row Crops
Forests and Campgrounds
Cities/Towns
Mines
Landfills
Parks

Sewage Treatment Plants
Drinking Water Intakes
Shopping Centers/Malls and Parking Lots
Roads/Highways
Golf Courses
Confined Animal Feeding Operations
Industrial Areas and any associated discharges

You are not limited to this list, nor will these things be present within every watershed. What is important is that you know how land is used in your watershed. With this knowledge you can interpret changes in stream health and help make wise decisions about watershed management.

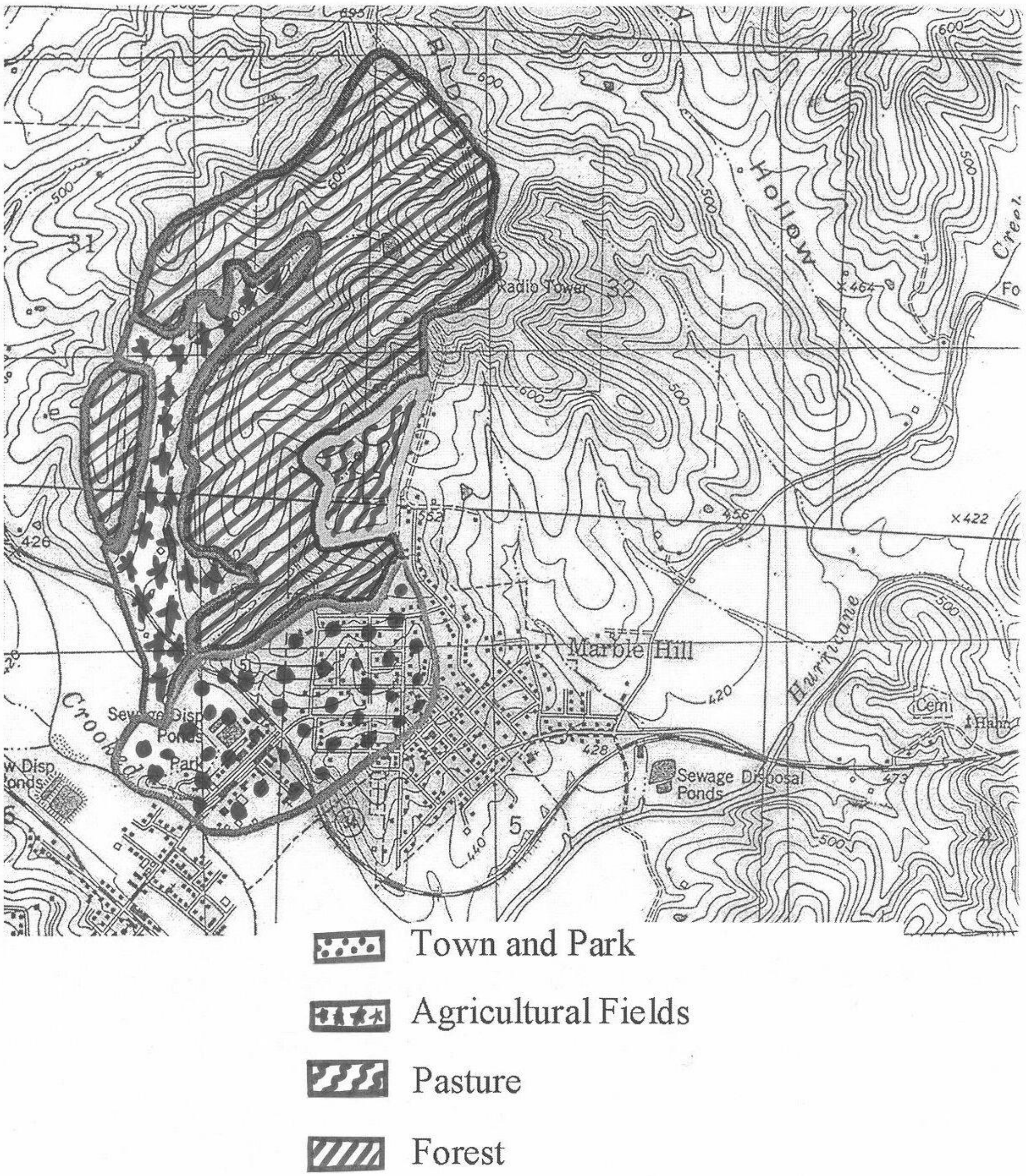
Again, watershed and land-use maps you create are for your own information and use. You do not have to submit the map to the program. However, <u>if you see a change in the watershed that you feel has affected your sampling results, be sure to make a note of that fact on all of the data sheets you submit.</u>

Land Ethics

"*That land is a community is the basic concept of ecology, but that land is to be loved and respected is an extension of ethics.*" – Aldo Leopold

Example of a "Land-Use Overlay" of a Watershed Map

Showing Major Land Uses



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